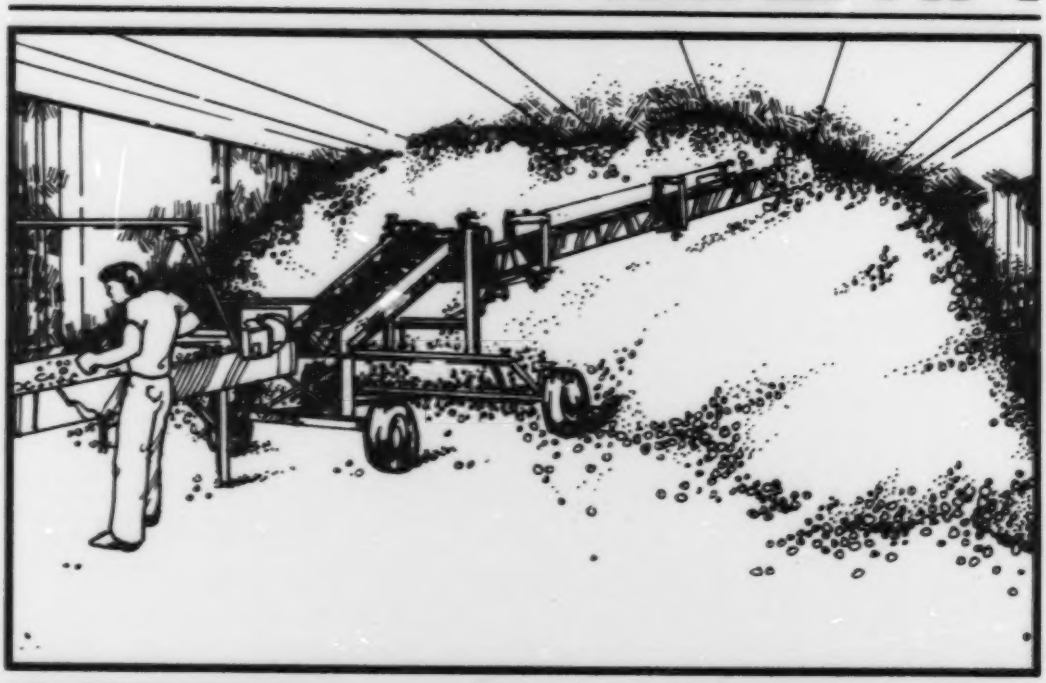
COST ANALYSIS OF POTATO STORAGE FACILITIES IN ALBERTA



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COST ANALYSIS OF POTATO STORAGE FACILITIES

IN ALBERTA

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SECTION I

INTRODUCTION

A properly constructed and well managed storage system should prevent the development of rot, retard growth of sprouts, reduce dehydration and excessive moisture loss, and reduce the number of pressure bruises and black spots. Spoilage of many perishable products can be delayed by controlling the post-harvest environmental conditions of temperature, humidity and atmospheric concentration of certain gases produced or consumed by plant material. The gases include carbon dioxide, oxygen, ethylene, and numerous volatile by-products of metabolism produced in minute amounts, which cause off-flavors and certain physical disorders. The physical disorders can only be controlled through modern storage facilities.

There is a concensus within agri-business and among vegetable and potato producers that Alberta lacks adequate vegetable and potato storage facilities. This concensus has been confirmed by the findings of the Storage Task Force Report[1]. The Storage Task Force recommended that existing storage facilities be upgraded and that new facilities be built to accommodate future expansion of the potato and vegetable industry.

Since the completion of the Task Force report, about 25 new storage facilities have been built. Despite the addition of new storage space, demand for more storage facilities remains high as the demand for potato and potato products has increased significantly during the last several years. Therefore, temporary and long-term storage facilities are essential for continuous supply of locally produced potatoes and vegetables.

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[1] Thomas R. Krahn, Alberta Horticultural Crops Storage Task Force Report Alberta Horticulture Research Centre, Brooks, Alberta, June, 1980.

Since 1972, imports of potatoes and potato products have increased from $0.8 million in 1972 to about $2.7 million in 1980, a total increase of 238 per cent or 27 per cent on the average per year.

This increase in imports reflects a significant increase in demand for fresh and processed potatoes in Alberta. If local production of potatoes is increased and storage facilities are expanded and modernized to extend the season for potato marketing, then consumer dependence on imports can be reduced significantly. Expanded and modernized storage facilities would help to ensure a supply of potatoes which could be stored from 4 to 10 months.

This study focuses on the costs of storing potatoes in Alberta. In other words, the study will evaluate the costs of constructing and operating different types of potato storage facilities.

Objectives of the Study

The major objective of this study is to document costs associated with the modern potato storage facilities. Specifically, the objectives of this study are:

1. To determine capital costs of new potato storage facilities, and
2. To estimate annual operating costs of potato storage facilities.

Source of Data

Data on optimum environmental conditions for the storage of potatoes were obtained from several publications prepared by the provincial and federal agriculture departments and from Alberta Agriculture personnel at the Horticulture Research Center at Brooks. Cost data for storage construction were collected through a personal survey of 15 potato producers who built new facilities during 1979 and 1981.

SECTION II

POTATO PRODUCTION IN ALBERTA

Production of Potatoes in Alberta

The area under potatoes has fluctuated between 16,000 and 18,000 acres over the last six years. In the early seventies, the area under potatoes remained steady at about 23,000 acres. By 1980, however, the area under potatoes fell to 16,000 acres, a decline of almost 40 per cent.

Potato production in Alberta has also fluctuated considerably between 1972 and 1981. The highest production of 204 174 tonnes occurred in 1973 and the lowest in 1978 at 149 129 tonnes. Although the area under potatoes remained stagnant during the mid-seventies, overall production improved because of higher yields. In 1980, the area under potatoes in Alberta was 16,000 acres and almost the same amount of tonnage was produced as in 1972 when the area under potatoes was 23,000 acres.

Details on the area and production of potatoes in Alberta from 1972 to 1981 are presented in Table 1.

TABLE 1 ACREAGE AND PRODUCTION OF POTATOES IN ALBERTA, 1972-1981

Year	Acreage (Acres)	Production (Tonnes)
1972	23,000	186 025
1973	23,000	204 174
1974	23,000	181 488
1975	18,000	154 265
1976	17,000	163 503
1977	17,000	167 695
1978	16,000	149 129
1979	17,000	173 185
1980	16,000	185 844
1981	16,200	168 321

SOURCE: Agriculture Statistics Yearbook, 1973 - 1981.

Imports of Potatoes and Potato Products into Alberta

Although demand for potatoes and potato products has been on the increase, domestic production of potatoes has not kept pace with the growth in demand. Therefore, much more emphasis has been placed on imports, the result being that imports have increased steadily since 1972. Imports of fresh and processed potatoes have almost doubled in volume from 1972 to 1979. Imports of these products in terms of value had almost tripled during the same time period. Imports of these products reached their highest level in 1978 to over $2.7 million and declined to $2.2 million in 1979 primarily because of lower prices. Although the volume of imports decreased considerably in 1980, the value of imports increased to about $2.7 million.

If domestic production of potatoes and potato products remains at the current level, then imports of these products could increase sharply over the next few years. Details of imports of potatoes and potato products from 1972-1980 are presented in Table 2.

TABLE 2 IMPORTS OF POTATOES AND POTATO PRODUCTS*, 1972 - 1980

Year	Quantity -(kg)-	Value -($)-
1972	10 457 917	779 190
1978	8 082 383	1 166 554
1974	9 721 768	1 502 228
1975	11 756 235	1 595 803
1976	16 206 899	1 768 887
1977	21 581 817	2 190 408
1978	15 211 470	2 743 319
1979	17 797 657	2 241 098
1980	12 518 750	2 662 275

*Include instant mashed potatoes, frozen potatoes, dried potatoes, sweet potatoes (fresh), potato seed and potatoes (fresh).

Source: Statistics Canada, "Imports - Commodities by Country, Province of Clearance - Western Provinces" Statistics Canada, 1972-1980.

SECTION III

POTATO STORAGE SITUATION IN ALBERTA

Current Storage Inventory

In 1979, the Alberta Horticultural Crops Storage Task Force investigated existing storage facilities and future storage requirements for all horticultural commodities, including nursery stock, flowers, vegetables and potatoes. The Task Force report provided a detailed inventory of storage facilities for potatoes and vegetables, number of storage facilities, capacity and type of storage facilities. It also provided estimates of storage needs during the next five to ten years.

Details of types of potato storage facilities and their capacities were as follows[1]:

TOTAL STORAGE CAPACITY	212 650 tonnes
Refrigerated storage capacity (bins)	10 889 tonnes
Non-Refrigerated	201 760 tonnes
- Rigid frame	47 777 tonnes
- Domes	14 519 tonnes
- Quonset	31 352 tonnes
- Root cellar	85 653 tonnes
- Bins	16 924 tonnes
1979 - 80 Unused capacity	5 447 tonnes

This storage capacity is scattered through Alberta from Peace River to Medicine Hat, but most of it is located in the Edmonton area and the irrigated areas of southern Alberta.

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[1] Thomas R. Krahn, Alberta Horticultural Crops Storage Task Force Report, Alberta Horticultural Research Centre, Brooks, Alberta June, 1980, Page 7.

The Task Force report on potato storage capacity in Alberta pointed out a number of concerns:

1. Root cellar capacity is 40 per cent of the total; of this capacity, 62 per cent or 48 730 tonnes was rated as being in poor or fair condition with life expectancy of 1-3 years, and requires immediate replacement.
2. Refrigerated capacity was only 5 per cent of the total and is concentrated in four operations.
3. On-farm storage (individually owned) accounted for 156 434 tonnes of capacity or 74 per cent of total capacity; 58 per cent of on-farm storage was of root cellar type.
4. Generally speaking, Alberta storage facilities lacked good ventilation and humidity control. Approximately 50 per cent of the capacity could benefit from improved ventilation and/or humidification systems.
5. Several new facilities have been constructed in the past several years, approximately 18 per cent of the total capacity. However, a more intensified contruction program would be required in the immediate future to replace out-of-date storage facilities.

Optimum Storage Conditions for Potatoes

Certain environmental conditions with respect to temperature, humidity and ventilation have been found to be optimum for the maintenance of potato quality during storage. Conditions for optimum storage vary slightly for fresh, processing and seed potatoes. Specific storage requirements for potatoes are summarized in Table 3.

Heating and proper ventilation of storage buildings are required to maintain proper storage conditions through the winter. Equipment to provide a high humidity is required if storage is to be extended through spring. Refrigeration is also required in Alberta to maintain proper storage conditions beyond the spring months.

TABLE 3 OPTIMUM ENVIRONMENTAL CONDITIONS FOR STORING POTATOES

Crop	TEMPERATURE (°C)	RELATIVE HUMIDITY (%)	VENTILATION RATE (L/S/tonne)
Fresh Potatoes	5-8*	90-95	5-8 **
Processing Potatoes	8-13	90-95	7-10
Seed Potatoes	4-5	90-95	5-8

*Dependent on processor requirement and variety.

**This volume should be used when ventilating. Ventilation does not need to be continuous. (L/s/tonne=litres per second per Tonne; 1 L/s/tonne-2 CFM/ton).

Optimum conditions vary slightly depending on potato variety and end use requirements. Potato storage facilities, in general, require the following:

1) Buildings well-insulated to RSI-5.0 (R30) or better to withstand cold temperatures and maintain a high indoor relative humidity (over 90 per cent) with minimum condensation.
2) Buildings structurally designed to withstand climatic loads and the forces on walls or bins as a result of the potato pile pressure.
3) A good ventilation system: one that controls temperature with a system of louvers to blend outdoor air for cooling, ductwork to distribute air through the potato pile, humidifier, and related controls.
4) Supplemental heat for some storage applications notably processing stock.

Optional features which some storage facilities include are: refrigeration to extend the storage season, concrete floors, and a loading and grading room. A concrete floor is highly desired for seed potato storage to improve sanitation, but it will improve handling

operations and maintenance in all storage facilities. There is a trend toward concrete floors for new storage construction.

Types of Potato Storage Facilities in Alberta

There are many types of potato storage facilities in terms of size, layout and structure. Storage may be of steel frame, frameless steel arch, laminated wood arch, wood frame or concrete. Storage are usually of two types, either a series of relatively small multiple bins of 500-700 tonne capacity, or large single or double bin structures that hold up to 4 000 tonnes.

The multiple bin structure is preferred for certain processing potato applications where more precise control of each bin is desired for conditioning of the produce. Because there are few new farm structures of this type, this particular storage has not been included in the cost analysis. The capital cost is estimated to be 40 to 50 per cent higher, and operating costs somewhat higher than the large bin farm storage.

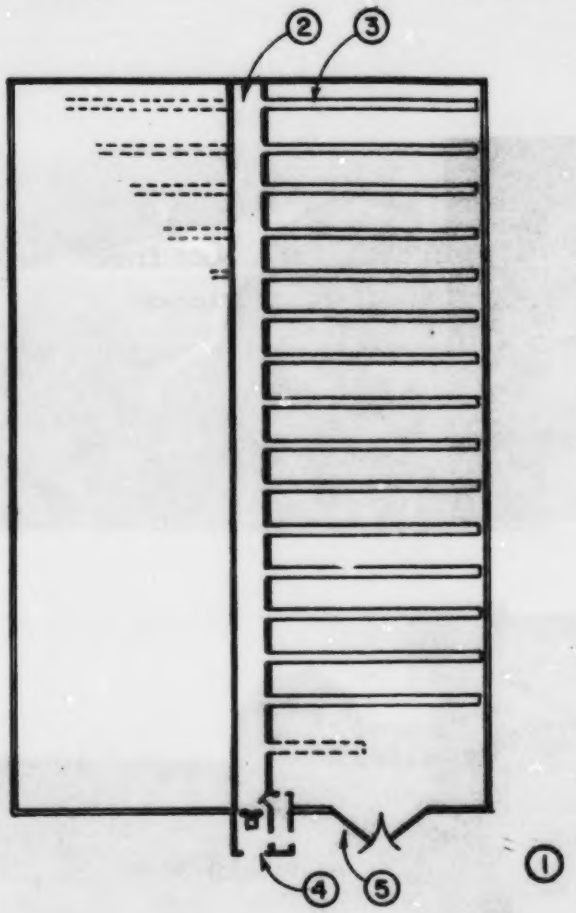
Potato storage facilities built in the past three years, and described in this report, were all of the single or double bin type. They were equally divided among the four structural types illustrated by Figures 1 and 2. One-third of the storage facilities had concrete floors.

Selected Potato Storage Facilities

To develop potato storage costs, four model facilities were proposed which are distinguished as wood frame, laminated wood arch, steel frame, and frameless steel arch storage. Basic storage is 15 metres by 60 metres with net usable space of 13.5 metres by 54 metres which can hold up to 2 000 tonnes of potatoes.

Specific storage types, as illustrated in Figures 1 and 2 are:

1) Wood frame - This is a stud wall structure, with clear span truss roof, concrete foundation, insulated with batt insulation to RSI 5.0 in walls and RSI 6.0 in the attic. Interior sheathing is of plywood, and exterior of metal, with either a steel or plywood and shingle roof system. Ventilaton is by a main plenum with lateral duct.



1. Typical storage plan, single bin or double-wide, as shown
2. Main air plenum
3. Branch ducts 3.0 m o.c.
4. Fan room, air blending louvers, controls
5. Insulated storage doors
6. Laminated wood arch
7. Frameless steel arch
8. Wood stud frame
9. Steel frame, double-wide shown (8 & 9 styles interchangeable)

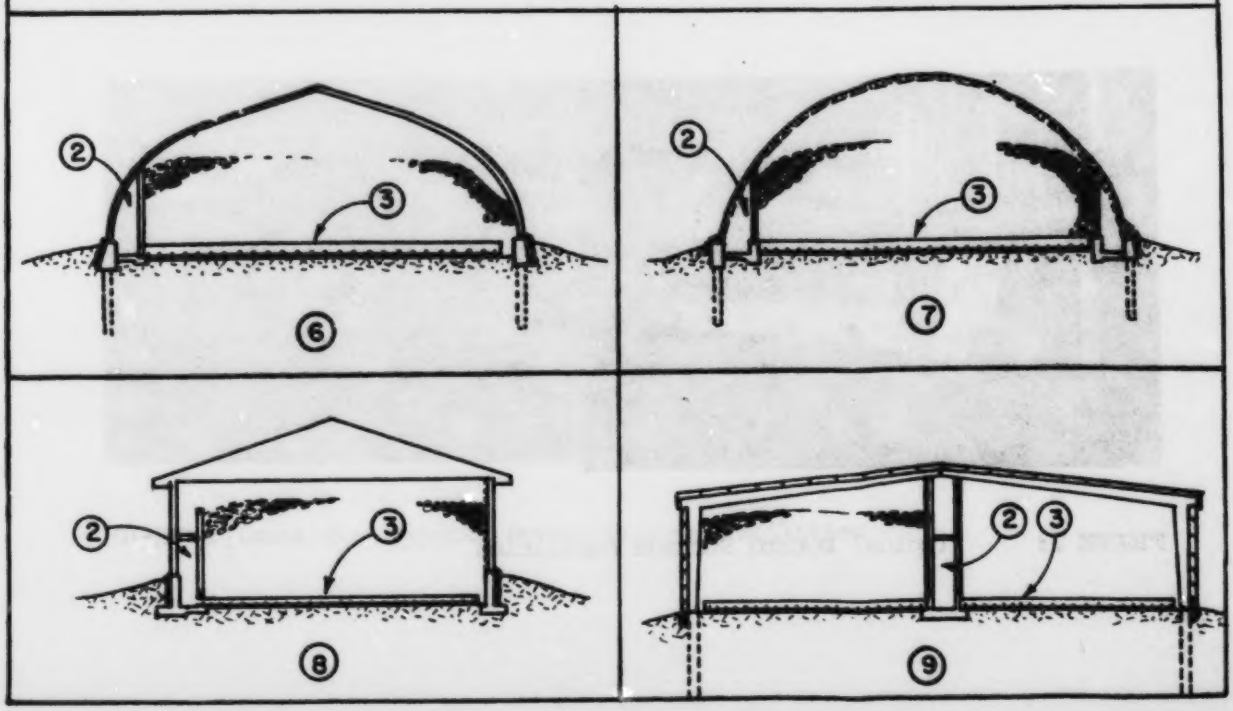


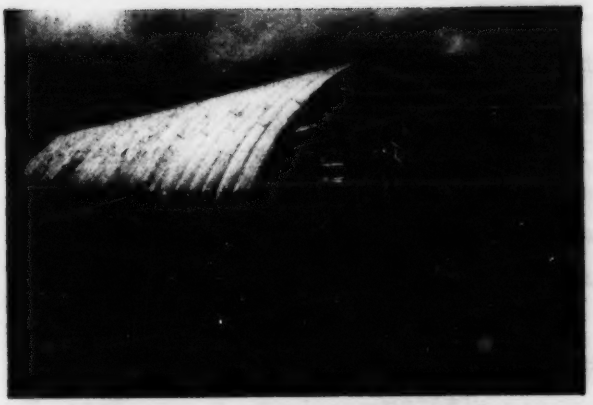
Figure 1 Typical Potato Storage Plan and Alternate Building Types

a) Wood frame storage

b) Laminated wood arch storage

c) Central plenum of wood frame storage under construction.

FIGURE 2: Typical Potato Storage Facilities



d) Steel arch storage under construction (note, insulation on outside of foundation).

e) Steel frame storage under construction.

f) Piling potatoes in an arch rafter storage.

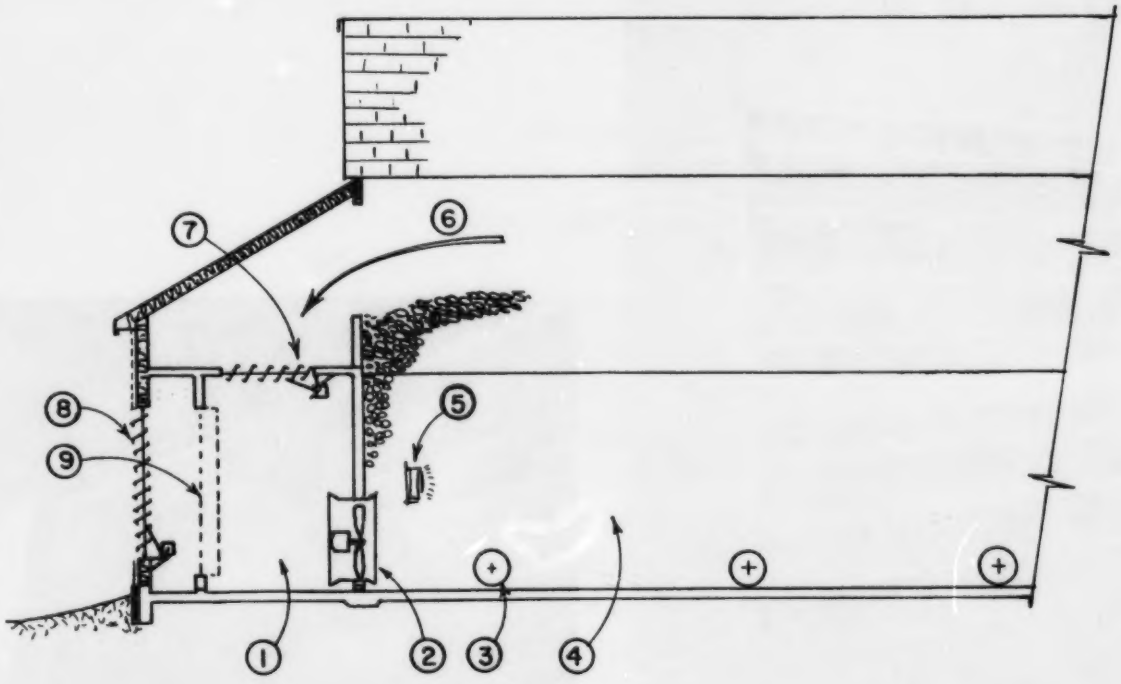
FIGURE 2 (cont'd): Typical Potato Storage Facilities

2) Laminated wood arch - This is a commercially manufactured laminated arch rafter structure, insulated to RSl 5.0 (R28) with batt insulation, or a combination of batts and urethane foam. A main air plenum is built along one side with lateral ducts at 2.4 to 3.0 m spacing. To accomodate this greater insulation thickness, and provide better structural strength for potato pressure, "heavy-duty" arches should be used. These arches would cost about $4000 per building which was taken into account in the cost analysis.
3) Steel frame - This is a large steel frames, typically at 4.8 m to 7.2 m spacing, on a deep concrete pile foundation. Steel purlins support exterior cladding of steel for walls and roof. Insulation is 100 mm urethane applied to the roof sheathing or above a steel ceiling liner panel. A large air plenum is incorporated in the building design, with lateral ducts for pile ventilation.
4) Frameless steel arch - This is a single-skin frameless arch structure, commonly referred to as a "steel quonset", insulated with 100 mm of urethane insulation to an RSl 5.3 (R30) value. The air plenum is typically along one side with lateral ducts at 2.4 to 3.0 m spacing. Because these structures are not normally designed for the pressure of a potato pile, a self-standing plenum structure on either side is required to retain the potatoes.

Note that all of the frameless steel arch structures, and the steel frame structures referred to by this report, were each from one manufacturer. Although the costs can be considered typical, they do not necessarily represent the cost for a broad spectrum of structures of these types.

Ventilation systems were all of proportioning louver type with damper motors, controls, main air plenum and under-pile distribution ducts (Figures 3 and 4). These were installed by two suppliers and were competitively priced.

For the steel frame and wood frame structures, the main plenum is incorporated in the structural system. Arch type structures reuqire construction of separate air plenums. For this study, ventilation component costs were adjusted to account for this factor. Lateral



1. Fan room and mixing chamber
2. Fan; approximately 8 L/S per tonne
3. Branch ducts under pile at 3.0 m o.c.
4. Main plenum
5. Humidifier
6. Return air from over pile
7. Return air louvers and control motor
8. Fresh air louvers and control motor
9. Door to isolate louvers in cold weather

FIGURE 3: Proportioning Louver Ventilation System Used in New Storage Facilities in Alberta.

(a)

(b)

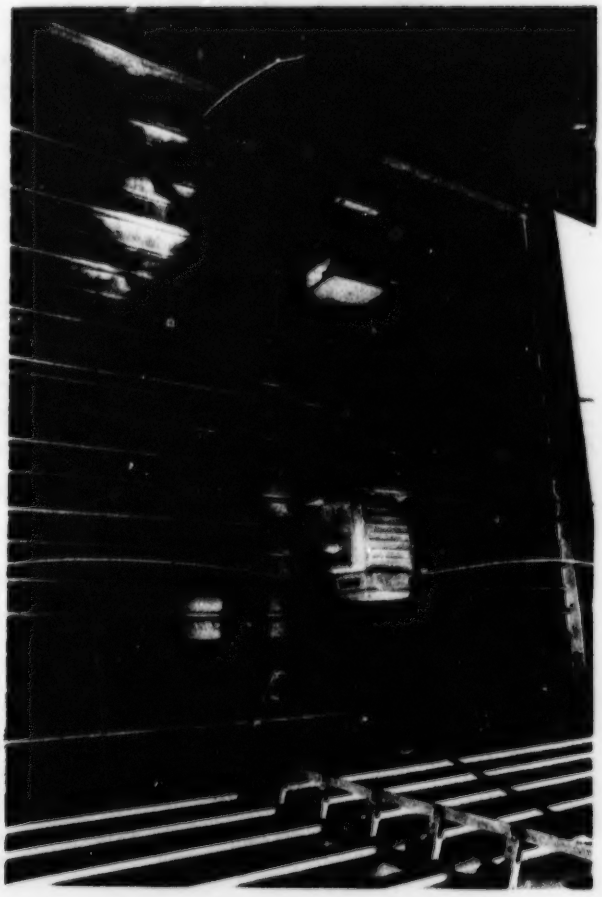


FIGURE: 4 Proportioning Louver System and Damper Motors (a) Fresh air intake louvers viewed from outside, and (b) Damper motors inside the mixing chamber.

ducts were either of corrugated metal pipe or P.V.C. plastic pipe, sized and spaced as required for air flow. The costs were similar for either system.

SECTION IV

POTATO STORAGE COSTS

Specific size and type of facilities were selected to determine potato storage costs (see selected potato storage facilities in Section III). Based on these facilities, equipment requirements were established to handle potatoes efficiently and economically in and out of the storage.

Building construction cost estimates were obtained from 15 potato producers in Alberta who built potato storage during 1979 and 1981. Equipment prices for potato storage were obtained from equipment dealers and verified by the potato producers who bought such equipment in 1980 and 1981.

To develop equitable potato storage costs, 1979 building costs were adjusted to arrive at comparable 1981 prices. As noted previously, the standard building size assumed is 15 metres by 60 mitres or equivalent in area, with storable capacity of 2000 tonnes. The storage facilities under study have compacted earth floors, well insulated structures and commercial ventilation systems.

Storage Construction Costs

i) Building Costs: The ability to control the storage environment for potatoes depends upon the kind of building facility and equipment, location, climate, building structure, building size, building shape and some of the factors influencing the cost of the complete storage unit. Any changes or variation in the basic structure of the building, would have a significant influence on the cost of the unit.

Estimates obtained from potato producers on building construction costs were used to compute interest and depreciation costs. Average life of the buildings (including ventilation and electrical systems) was assumed to be 20 years with 15 per cent salvage value.

ii) Equipment Costs: To obtain some estimates of storage equipment prices, local storage equipment suppliers were approached. These estimates were confirmed by the potato producers who have purchased such equipment during 1980 and 1981.

It was assumed that equipment listed below would be adequate for putting potatoes into storage and for grading, cleaning, and taking out of storage. Following is the suggested list of equipment for the storage facilities under study:

1. Piler with attached grading table
2. Unloader
   - Telescoping belt type or
   - Skid loader
3. High Pressure Cleaner
4. Loader (conveyor type) for loading trucks
5. Sizer (sizing and grading)

Capital Costs of Storage Facilities

Capital cost for the four types of storage facilities are presented in Table 4. The basic building construction cost, which includes site preparation, foundation, insulation to R-30 but no concrete floor, was $139,700 for wood frame, $117,450 for wood arch, $124,900 for steel frame, and $107,250 for steel arch.

For the purposes of this study the capital costs for the ventilation and electrical systems were assumed to be similar for all types of storage facilities. Capital costs averaged $16,300 for a ventilation system and $6,145 for electrical per storage. Data obtained from the potato producers showed considerable variation in capital costs for ventilation and electrical systems.

Although equipment requirements could vary significantly from one producer to another, equipment requirements for all four types of storage facilities were assumed to be the same. The equipment listed

TABLE 4: CAPITAL COSTS FOR DIFFERENT TYPES OF POTATO STORAGE FACILITIES

Type of Storage Structure	WOOD FRAME	WOOD ARCH	STEEL FRAME	STEEL ARCH
Size (15 m x 4.5 m x 60 m)	900 m^2	900 m^2	900 m^2	900 m^2
Capacity (tones)	2 000	2 000	2 000	2 000
Basic Building[1]	$139,700	$117,450	$124,900	$107,250
Ventilation System[2]	$16,300	$16,300	$16,300	$16,300
Electrical[3]	$6,145	$6,145	$6,145	$6,145
Storage Equipment[4]	$66,000	$66,000	$66,000	$66,000
TOTAL STORAGE AND EQUIPMENT INVESTMENT	$228,145	$205,895	$213,345	$195,695

[1]Contracted building construction cost estimates - includes foundation, site preparation, no concrete floor (for concrete floor add approximately $25 per square metre), insulated to R-30.

[2]Ventilation system includes fans, controls and lateral ducts.

[3]Electrical includes main service panel, lighting and 220 V service for potato handling equipment.

[4]Equipment includes piler, unloader (telescopic belt type or skid loader), sizing and grading (optional), pressure cleaner, and loader.

in the previous section was considered adequate for providing an efficient service for unloading potatoes into the storage, grading, cleaning and loading potatoes out of the storage. The value of this equipment was estimated to be $66,000 per storage. Annual costs were computed on that basis.

Total storage investment in the basic buildings, ventilation system, electrical system and potato handling system (including piler, unloader, sizer, cleaner and loader) amounted to $228,145 for wood frame, $205,895 for wood arch, $213,345 for steel frame, and $195,695 for steel arch. Details on total storage investment for all four types of storage facilities under study are presented in Table 4.

Table 5 shows total investment and annual investment costs of potato storage facilities under study. The investment costs are composed of interest and depreciation. Average life for buildings, ventilation system and electrical system was assumed to be 20 years with a 15 per cent salvage value. Interest on investment was calculated at 15 per cent per annum.

Investment costs for potato handling equipment were based on a 10 year life and 10 per cent salvage value. Rate of interest applied on such equipment was also 15 per cent per annum. Annual investment costs for buildings ranged from $16,698 for a steel arch to $20,876 for wood frame storage. Equipment costs were the same for all types of storage facilities.

Annual investment costs for buildings and equipment were the highest for wood frame storage at $32,261, followed by steel frame at $30,356, wood frame at $29,396, and a steel arch at $28,083. Annual investment costs per tonne were $16.13, $14.70, $15.18 and $14.04 for wood frame, wood arch, steel frame, and steel arch, respectively. Investment costs per square metre and other cost details for the four types of storage facilities are given in Table 5.

Operating Costs of Potato Storage Facilities

Storage operating costs include all those costs which are incurred during the operation of the storage facilities. The most common operating costs are:

TABLE 5: INVESTMENT AND ANNUAL INVESTMENT COSTS OF POTATO STORAGE FACILITIES

Type of Storage Structure	WOOD FRAME	WOOD ARCH	STEEL FRAME	STEEL ARCH
Size (15 m x 60 m x 4.5 m)	900 m^2	900 m^2	900 m^2	900 m^2
Capacity (tonnes)	2 000	2 000	2 000	2 000
Total Building Investment[1]	$162,145	$139,895	$147,345	$129,695
$/tonne	$ 81.07	$ 69.95	$ 73.63	$ 64.85
$/$m^2$	$ 180.16	$ 155.44	$ 163.72	$ 144.11
Equipment Investment	$66,000	$66,000	$66,000	$66,000
TOTAL INVESTMENT	$228,145	$205,895	$213,345	$195,695
ANNUAL INVESTMENT COSTS				
Buildings[2]	$20,876	$18,011	$18,971	$16,698
Equipment[3]	$11,385	$11,385	$11,385	$11,385
TOTAL	$32,261	$29,396	$30,356	$28,083
Investment Costs/Tonne	$ 16.13	$ 14.70	$ 15.18	$ 14.04
Investment Costs/m^2	$ 35.85	$ 32.66	$ 33.73	$ 31.20

[1] Includes basic building, ventilation and electrical systems.

[2] Assuming 20 years life and 15% salvage value.

[3] Assuming 10 years life and 10% salvage value.

1) Electrical power costs,
2) Insurance on the building, equipment and produce,
3) Chemicals mainly sprout inhibitor, and for storage sanitizing,
4) Repairs and maintenance,
5) Handling of potatoes in and out of storage,
6) Management and inspection of the storage.

Shrinkage and grade-out loss have been included as a part of operating costs because such loss occurs only if potatoes are stored. As noted in Table 6, shrinkage and grade-out losses are the major costs of storage. The extent of losses stated are representative of the existing facilities, and could vary widely depending on the quality of crop, nature of the market and/or end use, and management of the storage.

This study did not attempt to measure or differentiate losses between storage types. Such losses depend more on the environmental control, temperature, humidity and ventilation, and the management of storage system, than on the specific type of storage structure. Because, these storage losses are significant, it is important to invest in a good environmental control system and to exercise good management to minimize losses.

For the purposes of this report, shrinkage and grade-out losses were estimated at 6 per cent and 10 per cent, respectively. Storage losses were converted to monetary costs by assessing a value to the weight and quality changes that occur during storage. The value used in estimating the monetary costs of storage losses in this study was $100 per tonne, which is an estimate of the fall in-storage price of potatoes in Alberta.

Power cost estimates were based on the power consumption for ventilation (80 per cent), pilers and loaders (19 per cent), and lights (1 per cent). Current power rate for a storage facility of 2 000 tonnes, was used to estimate power costs. It was assumed that power costs would be the same for all types of storage facilities being studied. Ventilation power requirements which make up 80 per cent of costs, varied considerably with the type of storage management. Some

potatoes, mainly those for chipping, required a higher level of ventilation and longer ventilation intervals than seed or table stock potatoes. The power costs computed for this study (see Appendix I) allowed for intermittent operation of fans, typical of most storage practices in Alberta.

Insurance estimates were obtained for a typical storage operation in southern Alberta. Insurance rates were $5 per $1000 for wood buildings, and $3 per $1000 for steel buildings. Insurance on the potatoes in storage was estimated at 65¢ per month per $1000 worth of produce. It was assumed that with a storage season of nine months and intermittent marketing of produce, the average insurance would be equivalent to storing the entire crop for five months. However, where marketing practices and production contracts result in full term storage insurance costs would vary accordingly.

Sprout inhibitor is applied only once, shortly after harvest to prevent growth of tubers and deterioration of produce. The typical charge for application of sprout inhibitor was $1.65 per tonne. Chemical costs for the four types of storage were $3300 per storage.

Repairs and maintenance costs were assumed to be 1.5 per cent of wood building investment, 1 per cent of steel building investment, and 3 per cent of the equipment investment. These estimates were arrived at through consultations with the producers and based on some of the research published in the United States on potato storage. Computed repairs and maintenance costs for the four types of storage facilities are presented in Table 6.

Storage handling costs are incurred at the time of transferring potatoes into the storage, and loading potatoes out of the storage. It was assumed that with proper equipment, potatoes could be handled at a rate of 15 tonnes per hour. A rate of $6.75 per man-hour was charged to arrive at handling costs. Storage handling costs were assumed to be the same for all types of storage facilities.

Costs for managing storage (checking temperature, produce, humidity, and ventilation system, etc.) were based on one hour per day or about 200 hours for the duration of the storage. These costs were assumed to be the same for the four storage facilities.

TABLE 6: ANNUAL OPERATING COSTS OF POTATO STORAGE FACILITIES

Type of Storage Structure	WOOD FRAME	WOOD ARCH	STEEL FRAME	STEEL ARCH
Size (15 m x 60 m x 4.5 m)	900 m^2	900 m^2	900 m^2	900 m^2
Capacity (tonnes)	2 000	2 000	2 000	2 000
Power Costs[1]	$1,516.08	$1,516.08	$1,516.08	$1,516.08
Insurance[2]	1,460.75	1,349.50	1,092.05	1,039.10
Chemicals[3]	3,300.00	3,300.00	3,300.00	3,300.00
Repairs & Maintenance[4]	4,412.18	4,078.42	3,453.45	3,276.95
Handling[5]	1,800.02	1,800.02	1,800.02	1,800.02
Managing Storage[6]	1,620.00	1,620.00	1,620.00	1,620.00
Interest on Operating Capital[7]	850.78	823.94	770.73	756.90
ANNUAL OPERATING COSTS	$14,959.81	$14,487.96	$13,552.33	$13,309.05
ANNUAL OPERATING COSTS/TONNE	$7.48	$7.24	$6.78	$6.65
Shrinkage and Grade-out Loss[8]	$32,000.00	$32,000.00	$32,000.00	$32,000.00
Shrinkage and Grade-out Loss/Tonne	$16.00	$16.00	$16.00	$16.00
TOTAL OPERATING COSTS (including shrinkage and grade-out loss)	$46,959.81	$46,487.96	$45,552.33	$45,309.05
TOTAL OPERATING COSTS/TONNE	$ 23.48	$ 23.24	$ 22.78	$ 22.65

1 Details on power costs are provided in Appendix 1.
2 $5/$1000 for "wood" building and $3/$1000 for "steel" building investment, and 65¢/month/$1000 worth of produce for 5 months average storage period.
3 One treatment of sprout inhibitor during the storage life of potatoes @ $1.65/tonne.
4 1.5% of wood building and 1% of steel building investment, and 3% of equipment investment.
5 15 tonnes/hour - in and out of storage @ $6.75/hour.
6 Assuming 1 hour per day or about 240 hours for the duration of potato storage.
7 Calculated at a rate of 18% for four months.
8 6% shrinkage loss and 10% grade-out loss; assuming potato price of $100/tonne.

Interest on operating capital was computed at a rate of 18 per cent per annum for an eight month storage period. Details on interest costs on operating capital for the four storage facilities are given in Table 6.

Total annual operating costs, (Table 6) which include power, insurance, chemicals, repairs and maintenance, handling, managing storage and interest costs for the selected storage facilities amounted to:

	TOTAL	$/TONNE
Wood frame	$14,960	$7.48
Wood arch	$14,488	$7.24
Steel frame	$13,552	$6.78
Steel arch	$13,309	$6.65

These cost estimates should be very representative of potato storage costs in Alberta.

When shrinkage and grade-out losses of $16 per tonne were included, total operating costs (Table 6) were $46,960 for wood frame storage, $46,488 for wood arch, $45,552 for steel frame, and $45,309 for steel arch storage. Total operating costs per tonne were $23.48, $23.24, $22.78, and $22.65 for wood frame, wood arch, steel frame, and steel arch storage respectively.

Annual Storage Costs

Annual storage costs are the sum of investment costs and operating costs of potato storages. Table 7 presents a summary of investment costs, operating costs, and loss from shrinkage and grade-out. These costs have been discussed in detail in the previous sections. Total investment and operating costs (including shrinkage and grade-out loss/$16/tonne) amounted to:

TABLE 7: ANNUAL INVESTMENT AND OPERATING COSTS OF POTATO STORAGE FACILITIES

Type of Storage Structure	WOOD FRAME	WOOD ARCH	STEEL FRAME	STEEL ARCH
Size (15 m x 60 m x 4.5 m)	900 m^2	900 m^2	900 m^2	900 m^2
Capacity (tonnes)	2 000	2 000	2 000	2 000
TOTAL STORAGE AND EQUIPMENT INVESTMENT[1]	$228,145.00	$205,895.00	$213,345.00	$195,695.00
INVESTMENT COSTS	$ 32,261.00	$ 29,396.00	$ 30,356.00	$ 28,083.00
INVESMENT COSTS/TONNE	$ 16.13	$ 14.70	$ 15.18	$ 14.04
OPERATING COSTS	$ 14,959.81	$ 14,487.96	$ 13,552.33	$ 13,309.05
OPERATING COSTS/TONNE	$ 7.48	$ 7.24	$ 6.78	$ 6.65
SHRINKAGE AND GRADE-OUT LOSS	$ 32,000.00	$ 32,000.00	$ 32,000.00	$ 32,000.00
SHRINKAGE AND GRADE-OUT LOSS/TONNE	$ 16.00	$ 16.00	$ 16.00	$ 16.00
TOTAL OPERATING COSTS[2]	$ 46,959.81	$ 46,487.96	$ 45,552.33	$ 45,309.05
TOTAL OPERATING COSTS/TONNE	$ 23.48	$ 23.24	$ 22.78	$ 22.65
TOTAL INVESTMENT AND OPERATING COSTS	$ 79,220.81	$ 75,883.96	$ 75,908.33	$ 73,392.05
TOTAL INVESTMENT AND OPERATING COSTS/TONNE (INCLUDING SHRINKAGE AND GRADE LOSS)	$ 39.61	$ 37.94	$ 37.96	$ 36.69

[1] Includes basic building and equipment investment.
[2] Includes estimates for shrinkage and grade-out loss of 16%.

	TOTAL	$/TONNE
Wood frame	$79,221	$39.61
Wood arch	$75,884	$37.94
Steel frame	$75,903	$37.96
Steel arch	$73,392	$36.69

Readers or users of this information are advised to consider these figures as guidelines or estimates. Storage costs could vary significantly from one area of the province to another.

In this study, land costs were not included because of wide variation in land prices between rural and urban areas. Moreover, it was assumed that land costs would not have a significant impact on producer's decision to build new or renovate existing storage facilities.

SECTION V

SUMMARY

The need for improved potato storage facilities in Alberta has been well documented and emphasised by potato producers, researchers and agri-businesses. This study attempted to document potato storage costs for four types of potato storage facilities. In order to meet this objective, 15 potato producers were contacted to obtain data on storage facilities built during 1979 and 1981.

The data were standardized to develop cost estimates for the following four types of typical 2000 tonnes potato storage facilities:

1. Wood frame
2. Wood arch
3. Steel frame
4. Steel arch

Total investment for buildings, ventilation and electrical systems and equipment for the four types of storage facilities were estimated to be the following:

Storage Type	Building Investment	$/Tonne	Equipment Investment	Total Building and Equipment Investment
Wood frame	$162,145	81.10	$66,000	$228,145
Wood arch	$139,895	69.95	$66,000	$205,895
Steel frame	$147,345	73.67	$66,000	$213,345
Steel arch	$129,695	64.85	$66,000	$195,695

Annual investment costs, which consist of interest and depreciation on buildings and equipment, were as follows:

	Investment Costs	Investments Costs/tonne
Wood frame	$32,261	$16.13
Wood arch	$29,396	$14.70
Steel frame	$30,356	$15.18
Steel arch	$28,083	$14.04

Storage operating costs are composed of power costs, insurance (building, equipment and produce), chemicals, repairs and maintenance, shrinkage and grade-out loss, handling and managing of potatoes. Annual operating costs for the four types of storage facilities amounted to:

	Operating Costs	Operating Costs/tonne
Wood frame	$46,960	$23.48
Wood arch	$46,488	$23.24
Steel frame	$45,552	$22.78
Steel arch	$45,309	$22.65

Annual storage costs which are the sum of investment costs and operating costs of potato storages amounted to:

	Annual Investment and Operating costs	Annual Investment and Operating costs/tonne
Wood frame	$79,221	$39.61
Wood arch	$75,884	$37.94
Steel frame	$75,908	$37.96
Steel arch	$73,392	$36.65

The capital costs and annual operating costs determined in this study can be considered as reasonable estimates of the costs of storing

potatoes in Alberta. Individual growers are encouraged to compare this information with, or use it as a guideline for assessing their own storage costs, or in planning new facilities.

The significance of grade and shrinkage losses which may well exceed all other operating costs, should again be emphasized. Though these losses can never be eliminated, high quality storage facilities and good management will pay off by reducing such losses to a minimum.

Increasing demand for potatoes and potato products in Alberta provides an opportunity for local growers to expand potato production. An increase in domestic production would require expansion of the existing storage facilities in order to prolong the marketing season for locally produced potatoes. Well built storage facilities have several advantages: the potato producer can avoid selling all of his produce in the peak season; there is a good chance of realizing better returns during the off-production season; and a regular supply of the produce can be maintained year round.

APPENDIX I

POTATO STORAGE POWER COSTS

Size: 15 m x 60 m x 4.5 m

Capacity: 2 000 tonnes

Ventilation System:[1]

-capacity 8.0 L/s per tonne = 16000 L/S

-power: 2 fans @ 3.75 kW or 1 fan @ 7.5 kW (controls, etc.)

Piler: 50-60 tonnes/hr. capacity

12 kw motor capacity

Lights and miscellaneous: 3 kW

Electrical Utility rate: $3.30 per installed KVa plus

$0.03687 per kWh consumed

Transformer Size: 40 KVa (2/3 rd charged to potato storage)

Annual Power Costs

- Installation cost = $3.30/mo/KVa x 40 KVa x 0.667 x 12 months	= $1056.00
-Fans: 7.5 kW x 20 h/day x 30 days	= 4 500 kWh
7.5 kW x 4 h/day x 30 days x 7 months	= 6 300 kWh
-Piler/Unloaders: 12 kW x 140 hrs	= 1 680 kWh
Total Power Consumption	= 12 480 kWh
Power Rate	= $0.03687kWh
Power Cost = $.03687 x 12 480 kWh	= $460.00
TOTAL POWER COST (including installation) = $1056 + $460.00	= $1516.00
TOTAL POWER COST/TONNE	= $0.758

[1] Assumed Operation Methods:

Fans: 20 hrs/day for the first month

8 hrs/day for the next seven months

Pilers/Unloaders:

Piler 80% capacity - 60 hrs. loading

Unloader 66% capacity - 80 hrs. unloading

Lights: 1 hr/day - average over 8 months

APPENDIX II

COMPUTATION OF INTEREST AND DEPRECIATION

i) Interest on Investment:

Interest is defined as a sum paid or calculated for the use of capital. The sum is usually expressed in terms of a rate or percentage of the capital involved, called the interest rate.

Interest is charged for the use of capital invested. Had the capital not been invested to buy a specific asset, it could have been utilized elsewhere, either within or outside the firm, and would have brought some additional return to the firm.

For the purposes of this study, following rates of interest were used to compute interest on investment:

a) Buildings, ventilation and electricals - 15% per annum
b) Equipment - 15% per annum
c) Operating capital - 18% per annum

Interest computation methods:

$$\text{Interest on "buildings", etc.} = \frac{\text{Investment + Salvage value (15\%)}}{2} \times .15$$

$$\text{Interest on "equipment"} = \frac{\text{Investment + Salvage value (10\%)}}{2} \times .15$$

$$\text{Interest on "operating capital" (8 months)} = \frac{\text{Operating Capital} \times .18 \times .67}{2}$$

ii) Depreciation:

Depreciation is defined as the loss in value over time mainly as a result of obsolesence. In the case of buildings and equipment, it is that portion of the decrease in value resulting from ownership and the passage of time.

In computing depreciation, a 15 per cent allowance or salvage value was taken from the purchase price of the buildings. For equipment depreciation, 10 per cent salvage value was used. The following formula was used in arriving at depreciation for buildings and equipment:

$$\text{Depreciation} = \frac{\text{Purchase Price - Salvage value}}{\text{No. of Years of Life}}$$

Depreciation period used to calculate depreciation cost was 20 years for buildings (including ventilation and electrical system) and 10 years for equipment.

QUESTIONNAIRE FOR POTATO STORAGE COST SURVEY

Storage Description

Size _____

Capacity (tonne) _____

Type of Structure _____

_____

_____

Insulation (Type & Quantity) _____

_____

Air System _____
(duct spacing, plenum, brand name)

_____

Other Features _____
(refrigeration, grading area
special features, etc.) _____

_____

Cost Data

1. Building cost (as built, or materials only) _____

   _____

2. Site preparation (earthwork, soil tests, etc.) _____

   _____

3. Extra insulation (if not included in 1) _____

   _____

4. Air system (Fan & Controls) _____

   (Ducts, plenum, etc.) _____

5. Electrical work _____

   (if not included in 1 or 4) _____

6. Heating System _____

7. Concrete floor _____
   (if not included in 1)

8. Extra labor hired on contributed _____

9. Other expenses (crane rental, refrigeration, extras, etc.) _____

   _____

   _____

   _____

   _____